acoustical researches to the study of hydrodynamics. Shortly after this his physiological work induced him to again attack electrical problems. From the study of electrical oscillations he proceeded to a discussion of the most general form of expression for the potential of single "Stromelemente," and of the differential equations which determine the motion of electricity. In this first treatise on electrodynamics, Helmholtz aimed at giving a clear summary of all results previously obtained.

In 1871 Helmholtz was appointed to the professorship of physics at Berlin in succession to Magnus, which post he held until 1888. From this time onward he confined himself almost entirely to physics, and did very little more physiological work. In the following year, after the marriage of his daughter Käthe, and a visit to Scotland (where he met Tait, Andrews, Huxley, Brown, Sylvester, &c., and found golf less easy to master than science), he published further papers "On the Theories of Electrodynamics." In these he replied effectively to the criticisms of Bertrand, Weber, &c., and, basing his researches on Neumann's potential law, he investigated the various theories that had been put forward, showing that Faraday's assumption of dielectric polarity was the only theory consistent with observed properties of open and closed circuits. For a short time after this he applied his versatile genius to the problem of artificial flight and guidable balloons, made valuable contributions to the theory of the microscope and anomalous dispersion, and turned his attention to the origin of thunderstorms. He then returned for some years to his researches in electricity, and applied Faraday's theories to electrochemistry, producing papers on electric currents in fluids and "elektrische Grenzschichten."

In 1878 commenced his lifelong friendship with Hertz, whose investigations led Helmholtz back to his electrodynamical researches, and to the discussion of the electromagnetic theory of light. In 1881 he again visited England, where he delivered his famous "Faraday lecture" (one of the best lectures he ever gave), which was received with the greatest enthusiasm. The delivery of this discourse led him to further investigations in electrochemistry, and in "The Thermodynamics of Chemical Processes," published in 1883, he discusses the relations of chemical combination, heat, and electrical potential, distinguishing between the "free" energy of a system which can be entirely converted into work and the "bound" energy which cannot be so converted. After journeys to Rome and England, he undertook a masterly development of the principle of least action, a principle which he considered as probably being the controlling law of all reversible processes of nature.

During the last year of his professorship at Berlin Helmholtz returned to his work on electrical and thermodynamical chemistry, and to the development of the "principle of the decrease of free energy in chemical processes." In 1888 he was appointed president of the newly-founded Physico-technical Institute, a position in which he had comparative freedom from routine work, and so was enabled still more thoroughly to devote himself to those investigations for which he was so peculiarly fitted. His first great work in his new position was the adaptation of the equations of hydrodynamics to the case of layers of gases of varying density, and the application of his results to meteorological phenomena. The remaining four years of his life were devoted to more work on the mathematical theory of electricity. The most important papers were those on the application of the principle of least action to Maxwell's electrodynamical equations, on the electromagnetic theory of colour dispersion, and on Maxwell's theory of the motion of the ether. He died, after two months' illness, in 1894.

HAROLD HILTON.

THE EARTH-HISTORY OF CENTRAL EUROPE.

Central Europe. By Prof. Joseph Partsch, Ph.D. Pp. xiv+358; with maps and diagrams. (London: William Heinemann, 1903.)

PROF. PARTSCH'S geography of Central Europe forms a volume of the series "Regions of the World," edited by Mr. H. J. Mackinder. Written in German, it has been well translated by Miss Clementina Black, and has also undergone a little condensation, probably to its advantage. On the east and part of the south, the region has fairly definite physical boundaries, in other directions they are more often political; but practically Central Europe includes the two great empires of Germany and Austro-Hungary, with Switzerland, Belgium and the Netherlands on the one hand, Montenegro, Servia, Bulgaria and Roumania on the other. But in the main there is a general correspondence between the political and the physical boundaries of the region, for Central Europe, geographically speaking, as Prof. Partsch remarks, is a three-fold belt of Alps, of inferior chains and of northern lowlands, and wherever one of these elements dies out Central Europe comes to an end. This is the best natural definition, though we should have preferred the term central highlands to "inferior chains," and a little clearer insistence on the fact that the great mountain chains of Europe—the Alps, Pyrenees and Carpathians—are comparatively modern physical upstarts, the highlands being much more ancient regions, which, like some old families, have come down in the world. Still, Prof. Partsch makes it clear, in a chapter which certainly would not stand any more compression, that the development of Central Europe was a long and complicated story. His remarks on traces in the Alps of valley systems older than the present, illustrated by some rough but sufficient diagrams after Prof. Heim, will be very suggestive to students, though full justice can hardly be done to the subject within the limits of this volume, because mountain making in this region was a complicated and intricate process, involving many speculative elements. He does well also in calling attention to the aggressive habit of some rivers; the more active one cutting back through the old water parting and capturing the other's tributaries. The Maloya Pass affords, of course, a typical example of

this process, but it has probably occurred on an even greater scale under the shadow of Monte Rosa, where the depths of the Upper Val Anzasca have replaced summits which once connected the former peak with the ranges about the head of the Saaser Visp.

But before Alps, Pyrenees, or Carpathians existed, Europe had its river systems, which, notwithstanding their revolutionary effects, may still be traced. For these we must look to the great zone of the central highlands, which, in earlier days, must have marked the watershed of Europe so far as it then existed. We can, indeed, infer this history from Dr. Partsch's chapters, but its geographical outlines might well have been drawn with a firmer pencil. But his sketches of the different regions of Europe are clear and graphic, not forgetting the scenery and structure of the great Alpine chain, among which we may mention that of the Karsh region of the south-east, with its singular system of underground drainage, outliers of which may be found here and there farther west, notably in the Steinerne Meer, near the König See, and sometimes even in the Western Oberland. The chapters on the North German lowland and adjacent seas, on climate, ethnology, and economic geography are particularly good, and the value of the last is increased by small maps showing the chief productive areas of cereals, potatoes, vines, and other useful plants, as well as of minerals. The growth and relations also of the States into which Central Europe is now divided are briefly sketched, and the professor, in remarks upon the zeal lately shown by Switzerland in fortifying the heart of the Alps, takes some little pains to assure this State that the Teutonic Codlin, not the Gallic Short, is the friend. Who lives, will see.

We think Prof. Partsch makes "block" mountains and fractures a little too prominent, and object to his use of the term rift valley, though aware that he can quote precedents. If the Upper Rhine is a rift valley, we are unable to see how it differs from a "fault valley," *i.e.* one the general line of which has been determined by a fault or set of faults. Rift valley, in the most proper sense of that epithet, belongs to an extinct phase of geology, when the Alpine lakes were located in gaping fractures; it becomes almost absurd, as Prof. Partsch's own diagram shows, when applied to the above-named region or to the valley of the Jordan, but there are now geologists who take much pleasure, first in coining a dubiously appropriate term and then misapplying it with a lavish hand. One or two other dubious matters may as well be mentioned. It would be more correct to say that the crystalline rocks of the Mont Blanc *massif*, on their underground course towards the Bernese Oberland, plunge under the Alps of Vaud than of Fribourg; it is misleading to speak of schistose rocks being associated with the *nagelfluh*, and it would have been well to have spoken more dubiously about ancient coral reefs as origins of the East Alpine Dolomites. These, however, are but details. The book displays a temperate avoidance of extreme views, is well printed and illustrated, is clearly and attractively written, and will be most useful to both teachers and learners.

T. G. B.

OUR BOOK SHELF.

A Treatise on the Theory of Solution, including the Phenomena of Electrolysis. By W. C. D. Whetham. Pp. x+488. (Cambridge: University Press, 1902.) Price 10*s.* net.

THE present work is a rewritten and greatly expanded version of the author's book on "Solution and Electrolysis," published in 1895. It embraces practically all the material on the subject of solutions which is dealt with in the ordinary text-books of physical chemistry, except that part concerned with velocity of reaction and purely chemical equilibrium. The treatment throughout is characterised by great clearness, especially in the physical and mathematical portions, so that the volume may be warmly recommended to students of chemistry who desire to increase their knowledge of this department of the subject. The first chapter is on the general principles of thermodynamics, so far as they are necessary for subsequent developments, and is followed by chapters on the phase-rule and on solubility. Then comes the discussion of the phenomena of osmotic pressure, and the related magnitudes of the lowering of vapour pressure and of the freezing point, to be succeeded by a judicious chapter on the theory of solutions in which the hypotheses of molecular bombardment and of chemical combination are weighed and compared. Thereafter come four chapters on electrolytic conductivity and electromotive force, leading to an exposition of the theory of electrolytic dissociation. Two useful chapters on diffusion in solution, and on solutions of colloids, conclude the work.

A valuable appendix consists in the tables of electrochemical data compiled by the Rev. T. C. Fitzpatrick, and reprinted from the British Association Report of 1893. This extends to nearly 80 pages, and gives the conductivity, migration, and fluidity data which had at that time been determined for aqueous solutions. The book is also provided with an excellent index, which adds to its value as a work of reference.

The Study of Mental Science. By Prof. J. Brough. Pp. 129. (London: Longmans, Green, and Co., 1903.) Price 2*s.* net.

THIS very readable little book is a collection of five lectures in which Prof. Brough has urged with force and eloquence the claims of logic and psychology to take their place in every curriculum designed to give a liberal education. He claims that the study of logic develops and brings clearly before the consciousness of the student the "natural sense of method" which in the scientific specialist too often works in devious subterranean fashion. Logic, treated as a study of scientific method, should be taught at that stage in the educational course at which a general survey of knowledge has been made, and before the student enters upon one of the more specialised courses of study prescribed by the honours schools of our universities. This sound principle, practically interpreted, means that logic should be made an obligatory subject for all candidates in the matriculation examinations of the universities, that, for example, in the "Little-go" logic should replace "Paley," which for the intelligent student is merely a study in one branch of logic, the study of fallacies. For psychology our author does not attempt to claim so urgent and universal importance. It is rather as a complement to the "humanities" that he urges its claims. In the modern world "the panorama of spiritual presentation through which we move" grows overwhelmingly rich and varied, and the mind can hope to cope with it profitably only when its knowledge of spiritual fact is systematised by analysis of psychical processes and by clear conceptions of the elements so revealed and of the laws of their conjunction. Prof. Brough is known as an enthusiast